

BPA WMEG Follow-up Analysis

Stakeholder Meeting

November 4, 2024



Energy+Environmental Economics

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Agenda

- + Quick Review: WMEG Study Details & Prior Results for BPA
- + Quantitative Results for BPA: New WMEG Model Sensitivity Cases
- + Research on Additional Potential Impacts for BPA
- + Discuss Questions

Timeline of the WMEG study

2022
-2023

- WMEG (Western Market Exploratory Group) Cost and Benefit study conducted to provide WMEG members with credible information on the benefit of joining either **Markets+** or **EDAM**
- Presented BPA-Specific results in Sept 2023 workshops and posted case results

2023-
2024

- **Stakeholder requests and BPA interest in additional information** to expand understanding of prior results
- Different entities have announced market participation intentions (e.g. Nevada Energy, Idaho Power, and Portland General Electric for EDAM participation) **modifies the likely footprints relevant to consider**

April 2024-
Nov 2024

- BPA commissioned E3 to create additional sensitivities and scenarios
- Nov 4 Stakeholder meeting to discuss these results

Scope of Sensitivity Studies

(Tasks 1-8 introduced by BPA in prior stakeholder meeting)

- + **Task 1. EDAM Bookend (Single Westwide Market) Cases for Future Years:** extends cost-benefit results for the years 2030 and 2035
- + **Task 2. Lower Market to Market (M2M) Hurdle Rates:** understand cost-benefit impacts in WMEG cases if hurdle rates on market seams are lowered through improved market-to-market coordination
- + **Task 3. Low Water Year (+ Stressed Load):** simulate reduced hydro conditions and increased peak load
- + **Task 4. BPA EIM-Only:** simulate BPA remaining in the EIM and not joining either EDAM or Markets+.
- + **Task 5. Additional Transmission Capacity:** evaluate the impact of increased transmission capability between the Pacific Northwest and Desert Southwest regions within market footprints
- + **Task 6. Potential Capacity Value:** explore the potential value of regional peak load diversity and impact on capacity
- + **Task 7. Market comparison in interaction with WRAP*:** consider potential difference in ability either market's rules & practices to enable realization of capacity benefits
- + **Task 8: GHG Regulation Investigation*:** Understand impact M+ vs. EDAM rules regarding GHG on import
- + **Task 9. Alt Split 4A:** Cost-benefit results for updated potential footprint (including for 2030 and 2035 years)
- + **Task 10. Market Seam at CA Border:** Model footprint where all non-CA entities (including PacifiCorp) join M+
- + **Task 11. Alt Split 2NV:** Model footprint where Northwest + NV joins EDAM while Southwest joins Market+

**Task 7 & 8 work still pending for potential discussion in a future workshop*

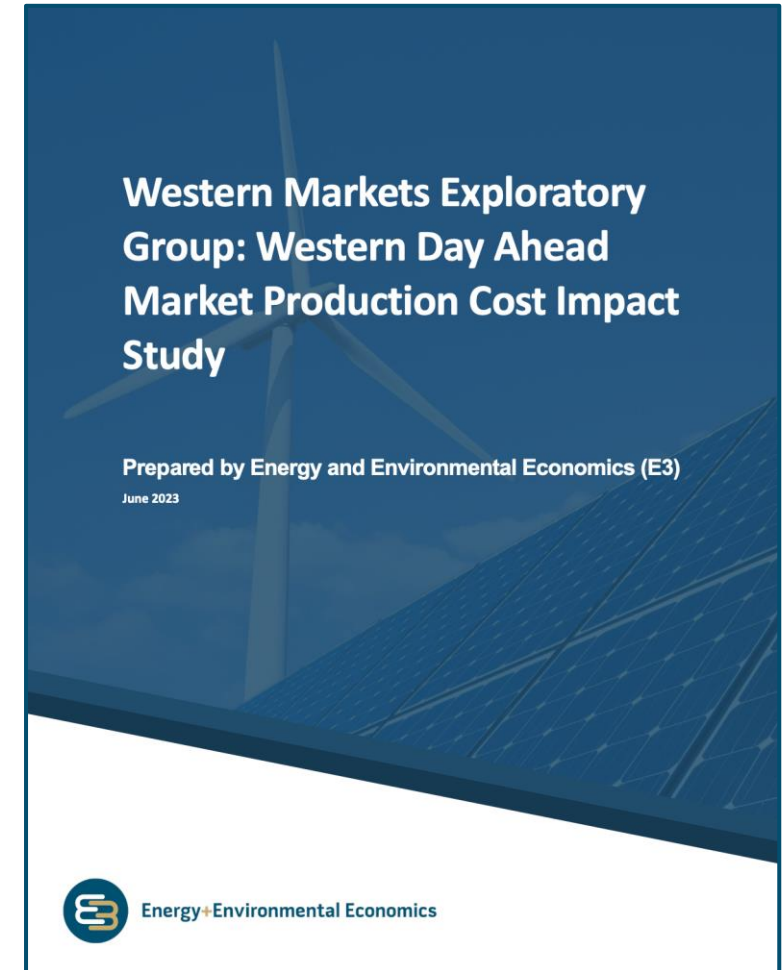
Review: WMEG Model & Results



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Western Market Exploratory Group Cost-Benefit Study Summary

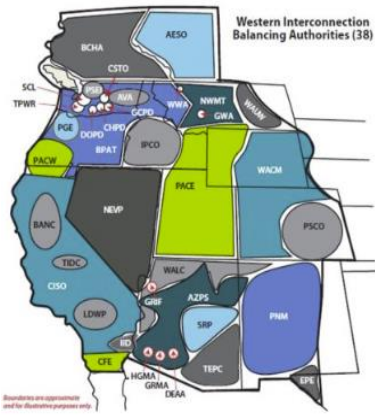
- + Analyzed impact for 26 Western utilities of different potential market footprints and features
- + Simulated scenarios using detailed PLEXOS production cost model of both day ahead (DA) and real-time (RT) operational stages and utilized confidential data from each WMEG member
- + Model's scope focused on variable production costs and energy market transactions and did not include calculating potential investment savings related to coordinated capacity, procurement, or transmission planning
- + Study focused on 2026 study year with some cases also represented for 2030 and 2035
- + **WMEG Cost-Benefit results:**
 - Showed modest range of system-wide impact compared to total system costs
 - Varied widely across entities, depending on market price changes, net market position, congestion revenue, and wheeling costs



Multiple Market Footprints Modeled in Initial WMEG Study

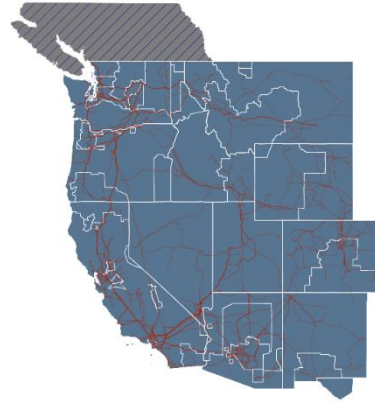
WMEG Study Core Footprints

BAU Case



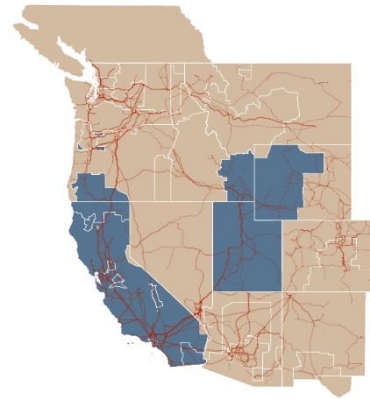
DA bilateral trading with RT within the existing EIM and EIS footprints

EDAM Bookend (Single Westwide Market)



A single west-wide DA and RT market (excluding Alberta and BC)

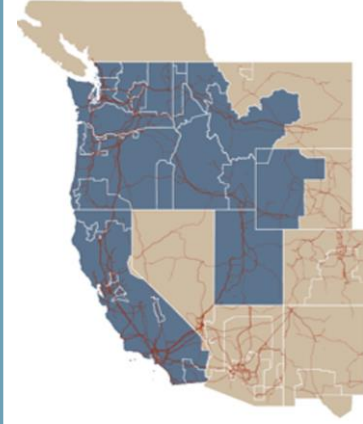
Main Split



EDAM: CA LSEs + PacifiCorp
Markets+: Rest of US WECC & BC

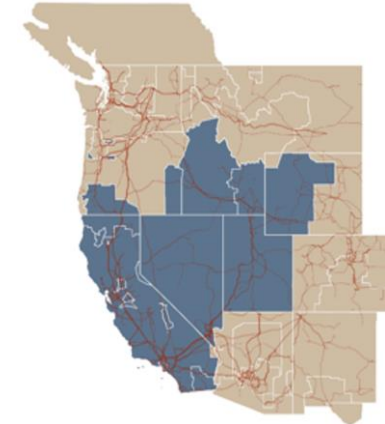
Alternative Footprint Examples

Alt Split 2



CA & PacifiCorp & Northwest in EDAM
Southwest & Rockies in M+

Alt Split 4



Main Split with NVE & Idaho Power to EDAM

+ The Core Scenarios compared a BAU Case with bilateral day-ahead trading only and EIM & WEIS in RT vs. a West-wide EDAM Bookend Case OR a Main Split Case with some entities participating in EDAM and others in Markets+

+ Four additional alternative footprints (2 shown here) were included to assess relevant sensitivity of interested to WMEG at the time of study



Credit: Greg MacDonald, PSE

BPA-Specific Results from Initial WMEG Study

+ Results reflect changes in production cost for generators owned by BPA, as well as changes in the cost of energy purchases for loads and revenue from energy sales (exports)

- Do not reflect potential changes to generation capacity or procurement decisions
- BPA-specific results include congestion revenue related to market price differences on key paths

+ Changes to wheeling revenue were also an important consideration for BPA

- The model treats wheeling charges (and revenue) as a variable cost that is applied to all exports from BAA or Market footprint
- In actual practice, the majority of BPA's current transmission wheeling revenue is for long-term contracts, which counterparties may continue to renew in a market scenario for different reasons
- Remainder of this presentation focused on **Net Cost Excluding Wheeling** (but data on wheeling results are also posted for stakeholders)

BPA-Specific Results WMEG Core Cases 2026

Cost/Benefit (\$ millions)	Case		
	BAU (2026)	EDAM Bookend (2026)	Main Split (2026)
Load Cost	921.7	944.0	923.6
Generation Cost	131.3	131.3	131.3
Reserve Cost	0.0	0.0	0.2
Generation Revenue	-1343.1	-1489.6	-1370.3
Reserve Revenue	0.0	0.0	0.0
Wheeling Revenue	-251.4	-5.5	-31.8
Congestion Revenue	-49.9	-60.1	-52.7
GhG Revenue	0.0	-0.1	-0.8
Net Cost	-591.3	-480.1	-400.5
Net Cost vs. BAU		111.2	190.8

+ The results shown here indicate BPA's changes to net cost as an EDAM or Markets+ participant vs. BAU under two bookends:

Bookend 1: Assumes all BPA wheeling revenues are variable and change in market cases

Bookend 2: Assumes all wheeling revenues are unchanged in market cases vs BAU

Net Cost excl. wheeling vs. BAU	-339.9	-474.6	-368.7
		-134.7	-28.8

In original WMEG Study, BPA net costs (excl. wheeling) in EDAM Bookend are -\$475M (\$135M better* than BAU) and in M+ (Main Split) are -\$369M (\$29M better than BAU)

[*Lower net costs are better for BPA]

Updated Accounting for Generation Revenue for Slice Customers

- + The original BPA results from WMEG modeled BPA benefits as including slice customers' share of hydro, but BPA benefits did not account for slice customer load cost
- + In discussion, BPA and E3 decided to update benefit accounting to reflect a more accurate balance of the impact for slice customers
 - Applied a 15% reduction to BPA generation revenue for all cases, which reflects BPA's estimated share of total generation attributed to slice customers
 - Results in BPA benefits based on a more balanced position of generation vs. load

After adjusting for Slice Revenue, BPA net costs in EDAM Bookend are -\$251M (\$113M better* than BAU) and in M+ (Main Split) are -\$163M (\$25M better than BAU)

[*Lower net costs are better for BPA]

Note: negative values for net cost represent net revenue that accrue to BPA customers, so more deeply negative net cost values are better for BPA customers

Accounting shown for all case comparisons today: excludes slice share of gen revenue

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Less: Gen Revenue for Slice	201.2	223.4	205.5
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Adjusted Results

Adjusted BPA Gen Revenue	-1140.1	-1226.2	-1164.8
Net Cost excl. wheeling vs. BAU	-137.9	-251.2	-163.3
		-113.3	-25.4

BPA Energy Benefits from WMEG Model Sensitivity Cases (Tasks 1-5 & 9-11)



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Sensitivity cases explored a range of additional questions

+ Five focus questions considered for sensitivity cases

- How would **different market footprints** impact BPA benefits of market participation?
 - 4 Additional Market Footprints Modeled: BPA EIM Only (Task 4); Alt Split 4A (Task 9); Non-CA Westwide M+ (Task 10); Alt Split 2NV (Task 11)
- How do BPA benefits of different footprints **change in later simulation years?** (Task 1)
- How would **dry hydro conditions or stressed summer & winter loads** affect BPA market benefits? (Task 3)
- How would **improved Market to Market Coordination** impact BPA market benefits? (Task 4)
- How would **improved Northwest to Southwest transmission capability** impact BPA market benefits? (Task 5)

+ For each question we:

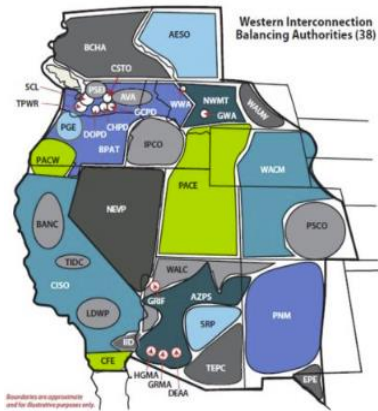
- Summarize changes E3 used to simulate the issues using the WMEG model
- Show the key impact on BPA market participation benefits
- Discuss the primary drivers of that impact

Additional Market Footprints Considered in BPA follow-up Study

Key Question: How would different market footprints impact BPA benefits of market participation?

Footprints Compared

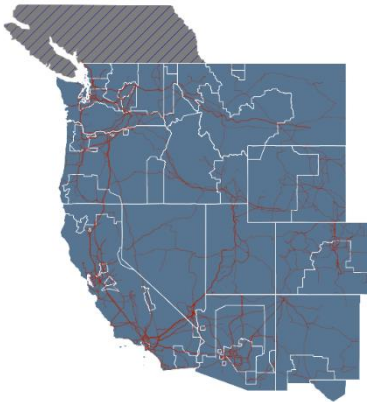
Business as Usual



DA bilateral trading only with RT within the existing EIM and EIS footprints

EIM only

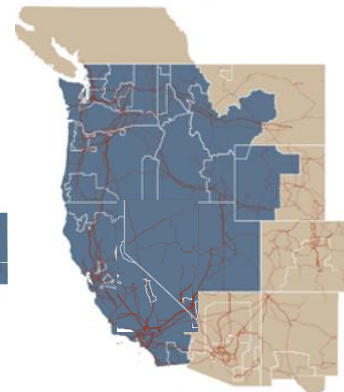
Westwide Market



Single DA and RT market that covers the entire WECC excluding Alberta and BC

Single Market

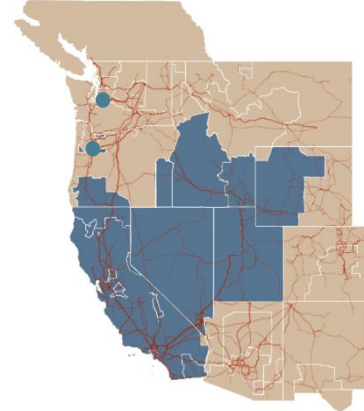
Alt split 2NV



EDAM: CA, PacifiCorp, NVE, all Northwest
Markets+: Southwest and Rockies

EDAM

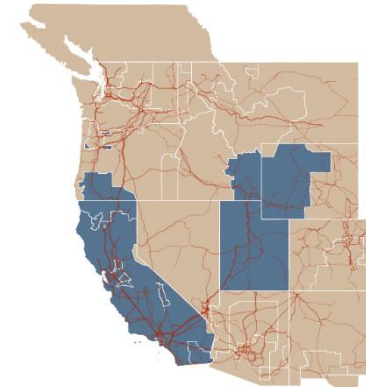
Alt split 4A



EDAM: CA, PacifiCorp, NVE, Idaho Power, PGE, SCL
Markets+: Rest of US WECC & BC

Markets+

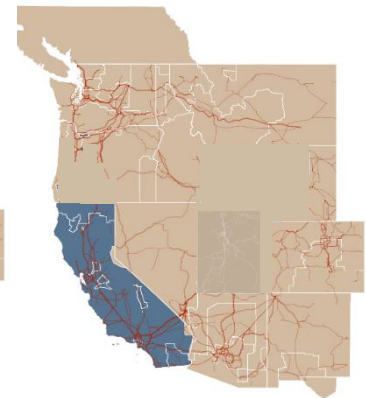
Main Split



EDAM: All CA LSEs + PacifiCorp
Markets+: Rest of US WECC & BC

Markets+

Non-CA Westwide M+



EDAM: CA LSEs only
Markets+: Rest of US WECC & BC

Markets+

BPA in:

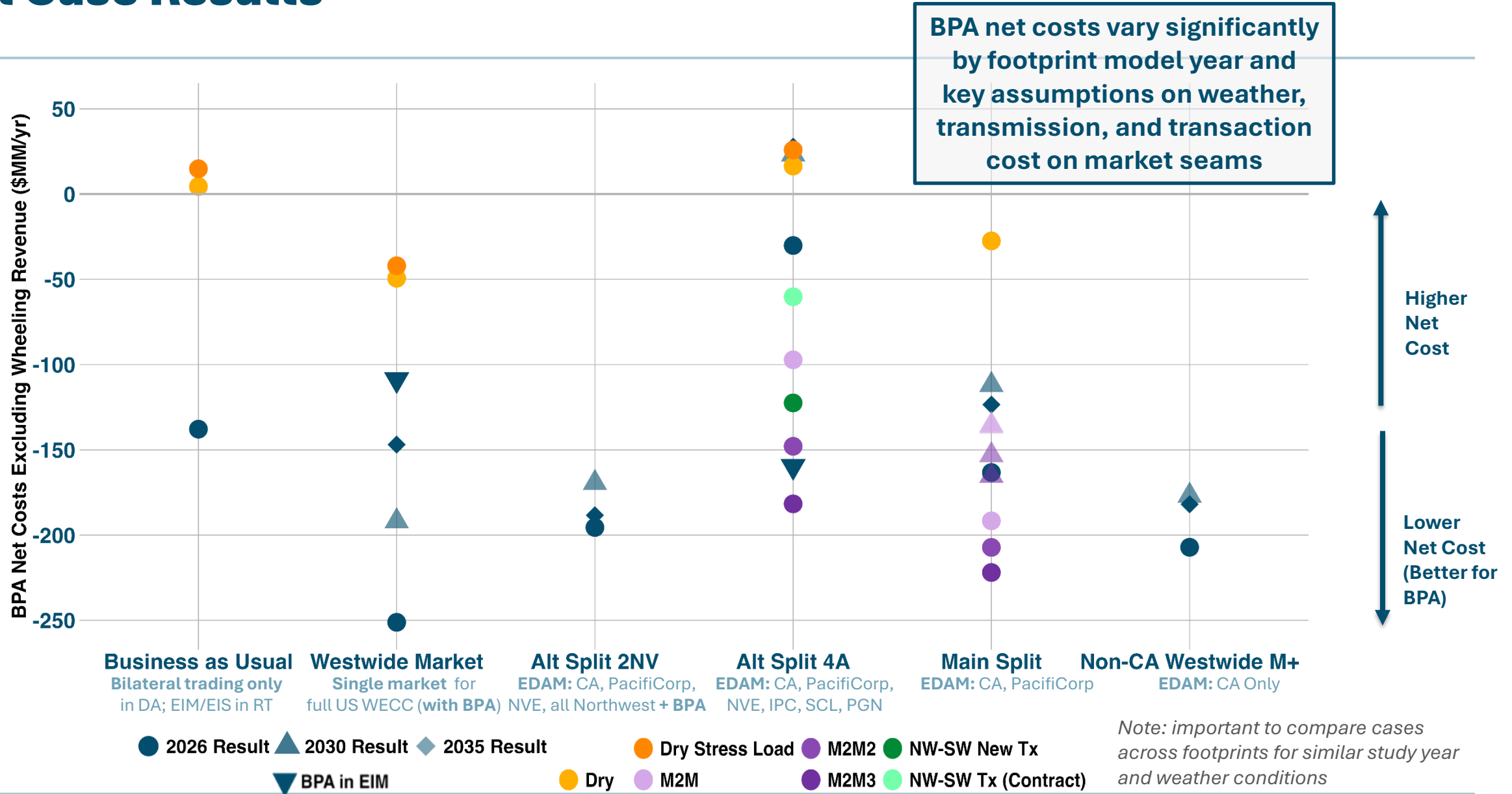
+ Added 3 new footprints to initial cases from WMEG for certain cases: **Alt Split 2NV, Alt Split 4A, and Non-CA Westwide M+**

+ Also modeled **BPA in EIM only** as a sensitivity to Westwide Market and Alt Split 4A



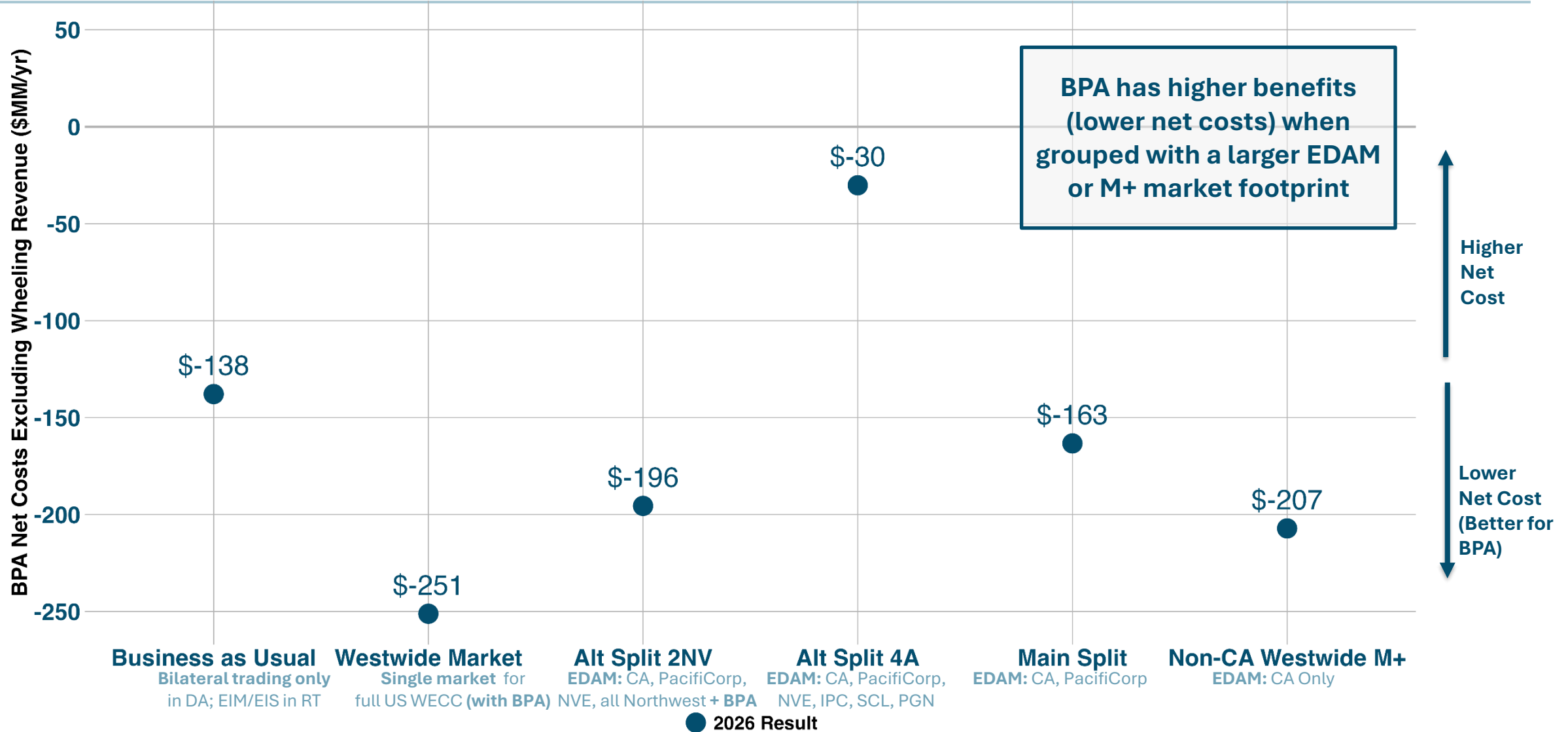
Credit: Greg MacDonald, PSE

All Case Results



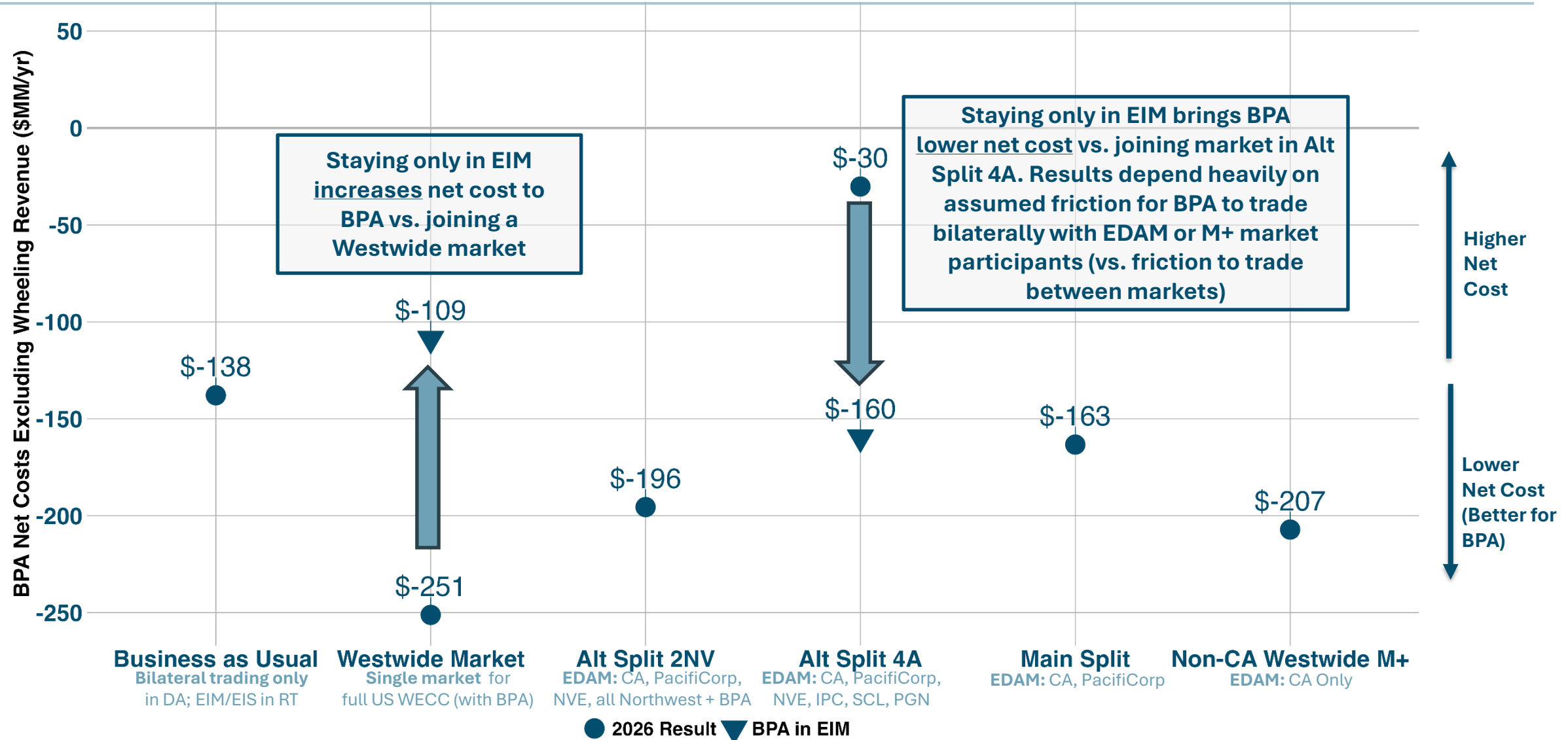
2026 Case Results by Market Footprint

(All results shown as Net Cost to BPA excluding Wheeling)



2026 Case Results by Market Footprint (with BPA in EIM Only)

(All results shown as Net Cost to BPA excluding Wheeling)



Results over time reflect evolving Installed Capacity across WECC for 2030 and 2035 simulation years

Key Question: How would different market footprints impact BPA benefits of market participation?

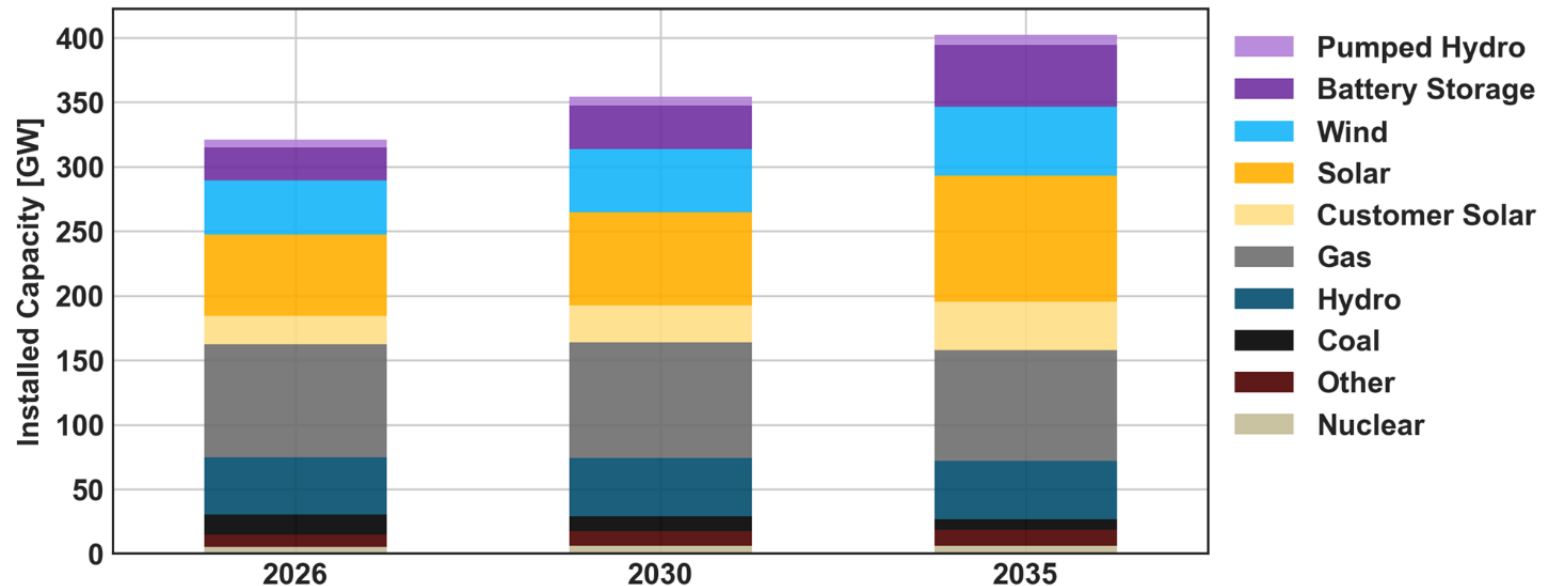
+ Compared to 2026 study year, WMEG simulations for 2030 and 2035 reflected updated loads and generation build across the Western Interconnection

- For BPA, no significant generation build changes while load grows modestly, leaving less energy for off system sales

+ For BPA follow-up work, simulated later years for additional footprints

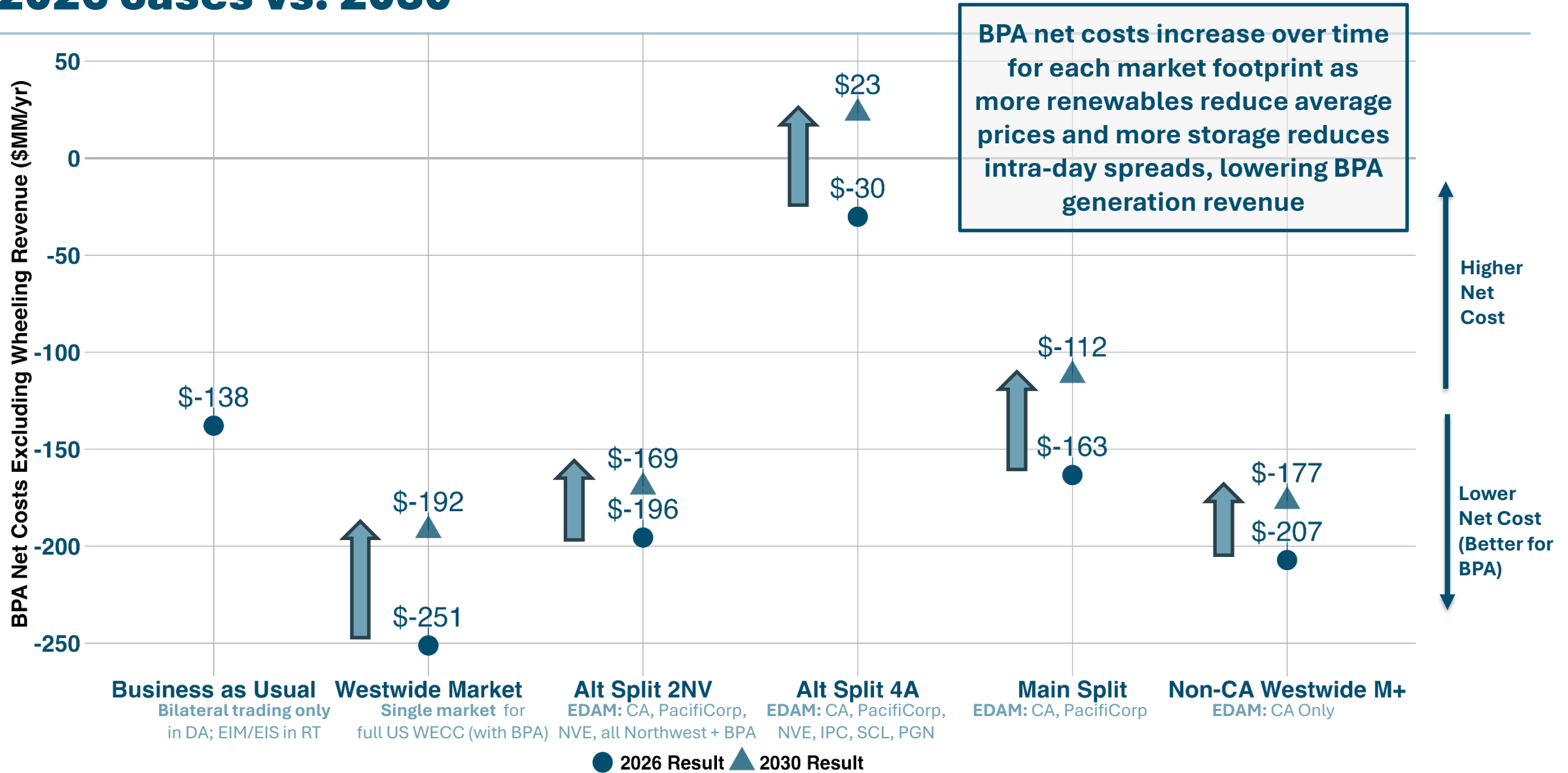
- Current scenarios maintained the 2030/35 load and generation assumptions developed for WMEG
- Current cases did not model additional forms of greater integration (e.g., ancillary services market or full RTO)

US WECC-wide Generation installed capacity by Study year (GW)

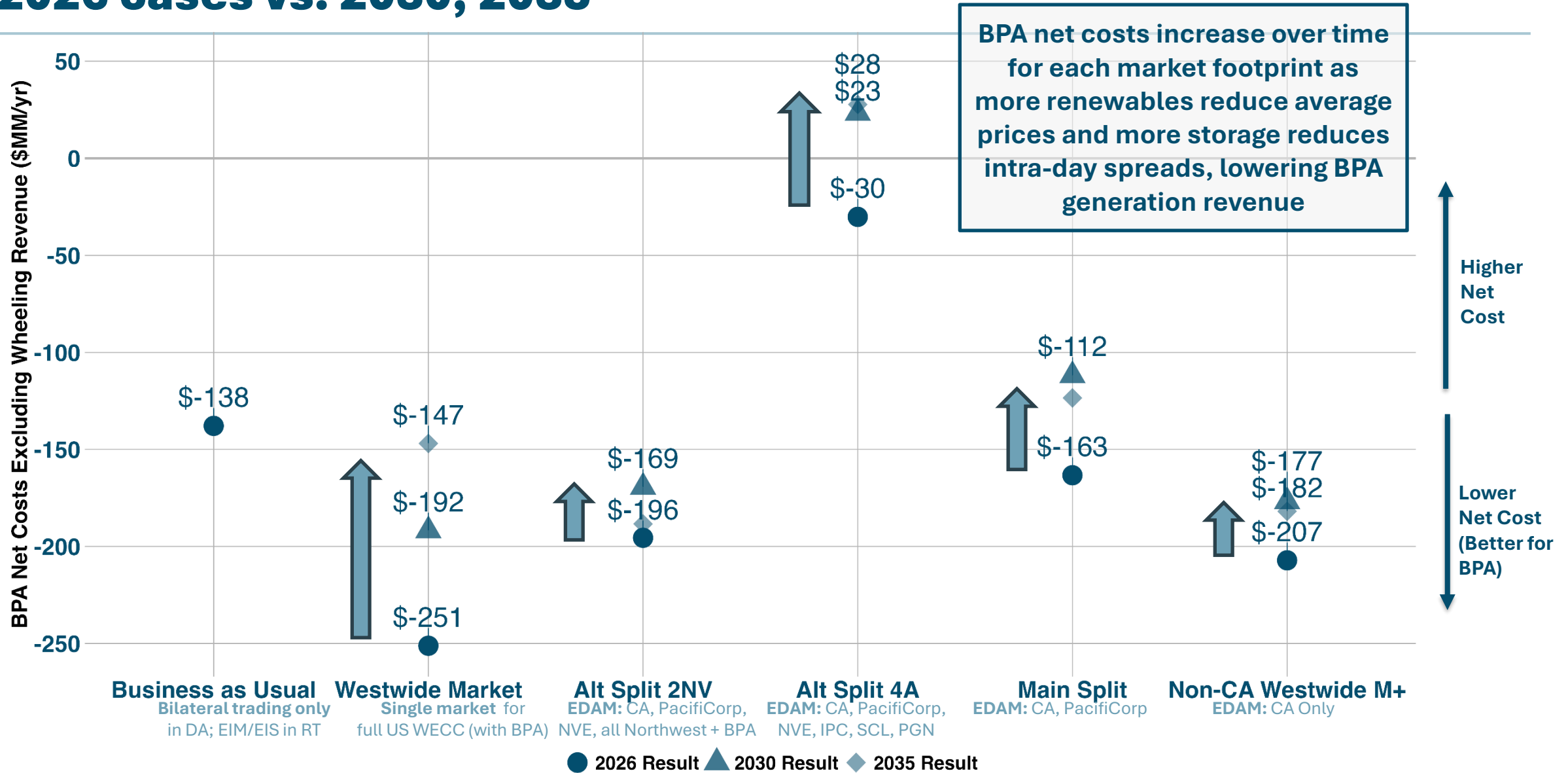


The starting database for the study was the 2032 Anchor Data Set (ADS) created by the Western Electric Coordinating Council (WECC) with subsequent modifications for both WMEG member areas and non-WMEG areas

BPA Market Participation Impact over time: 2026 cases vs. 2030

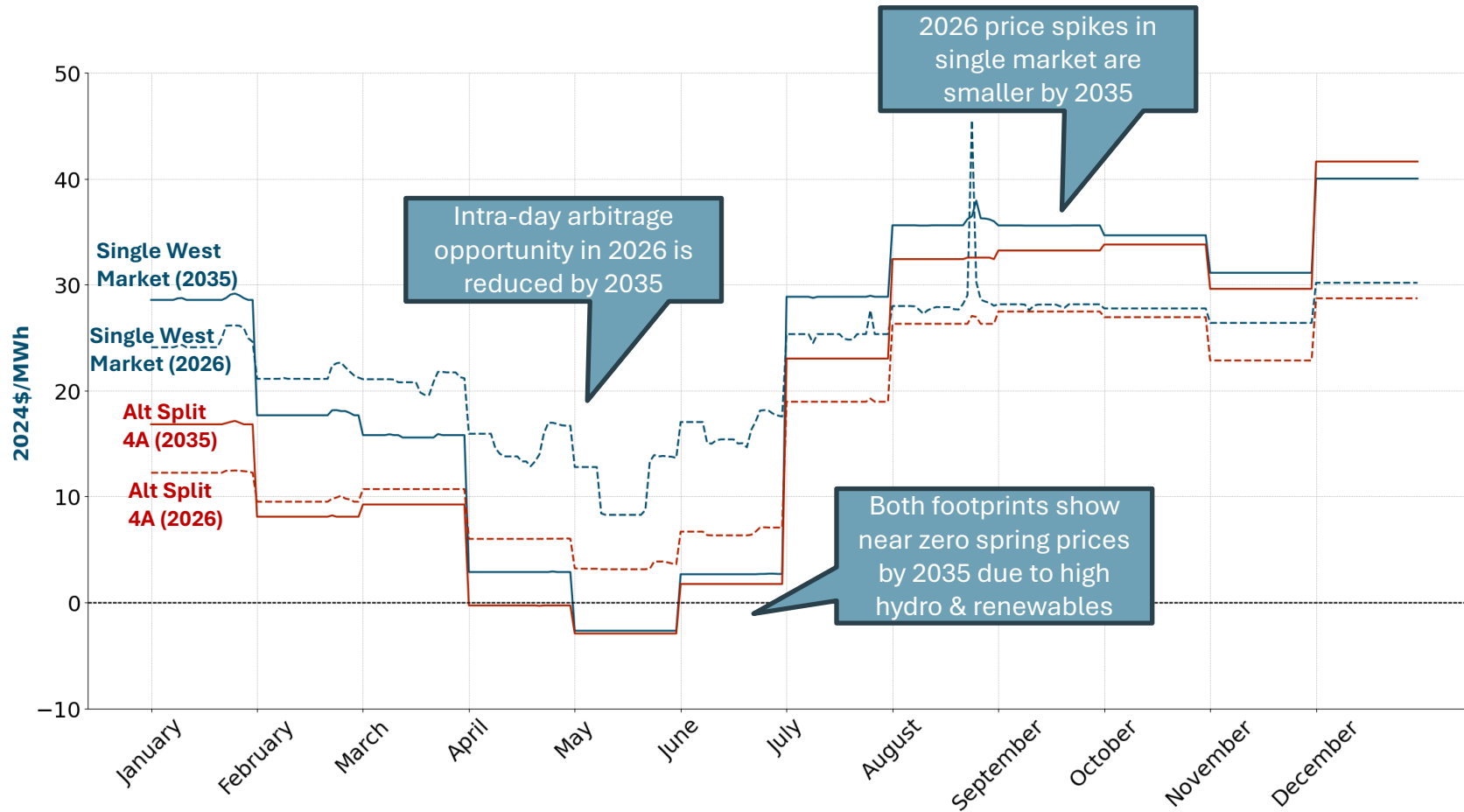


BPA Market Participation Impact over time: 2026 cases vs. 2030, 2035



Primary driver of results in later years: Intra-day Price spreads for BPA region become flatter & more similar for all market footprints

Month-hour Average Price at BPA WA Zone for 2026 & 2035 in Single Westwide Market & Alt Split 4A

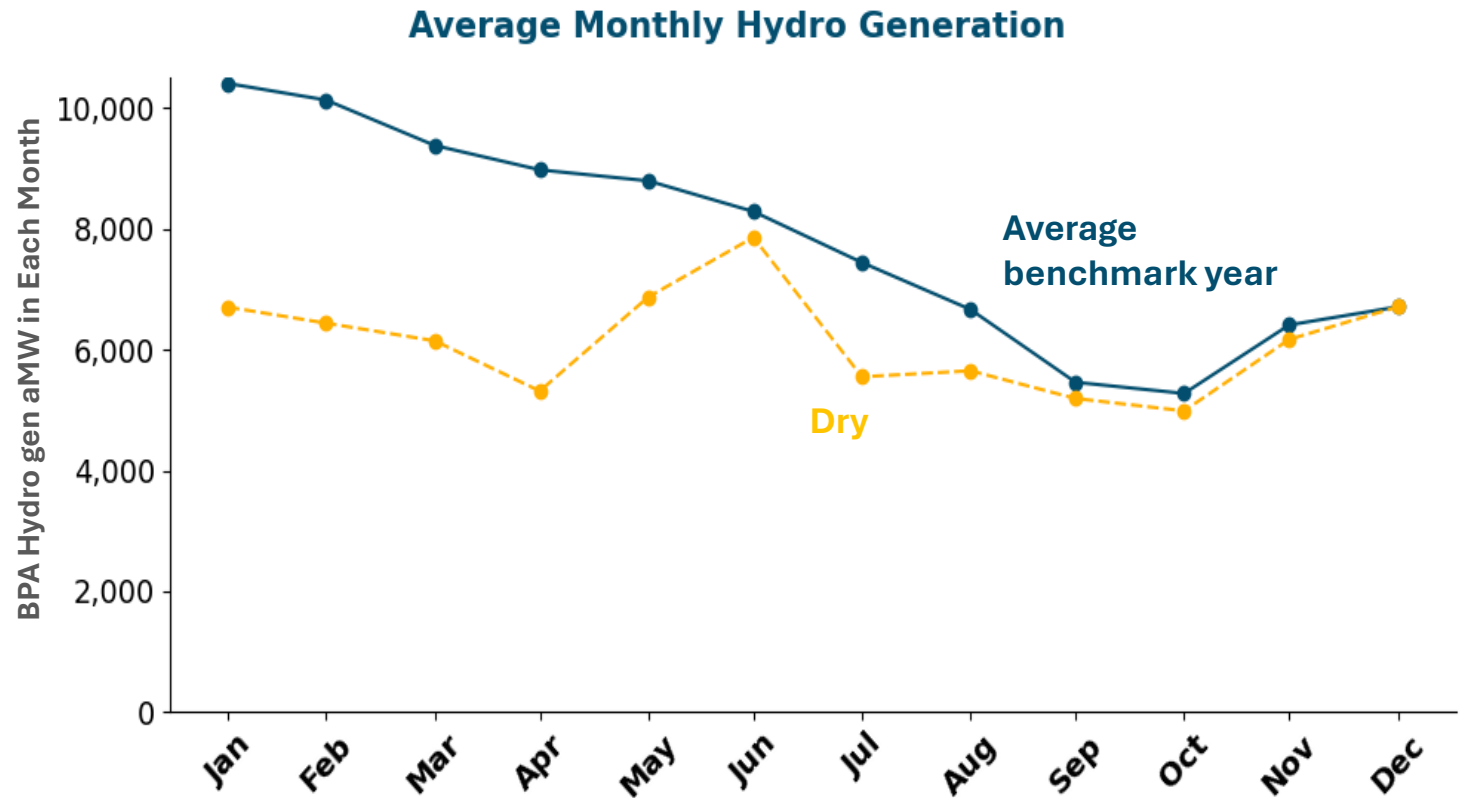


Dry Hydro Conditions & Stress Load Sensitivity Cases

Key Question: How would dry hydro conditions affect BPA market benefits?

- + **Low Hydro Condition is based on the lowest 10th percentile hydro generation**
 - Monthly reduction is determined by the fraction of p10 historical generation (1988 – 2017) over median hydro year used for WMEG benchmark cases (2000)
 - The monthly reduction % is then applied to hydro in all NW zones
- + **Assumed no change to hydro in WECC outside of NW region**
- + **BPA shows larger differences in Winter & Spring vs. Summer & Fall conditions**

Season	P10 / median hydro year gen.
Winter	76%
Spring	66%
Summer	83%
Fall	95%



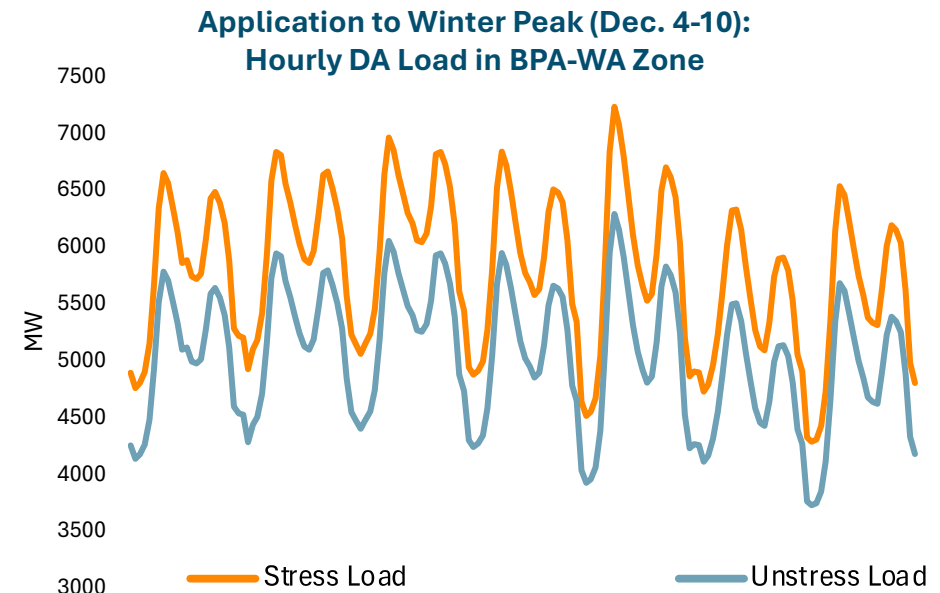
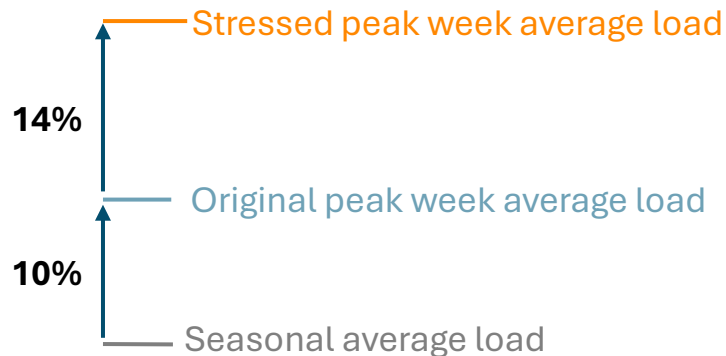
Dry Hydro Conditions & Stress Load Sensitivity Cases

Key Question: How would stressed summer & winter peak loads affect BPA market benefits?

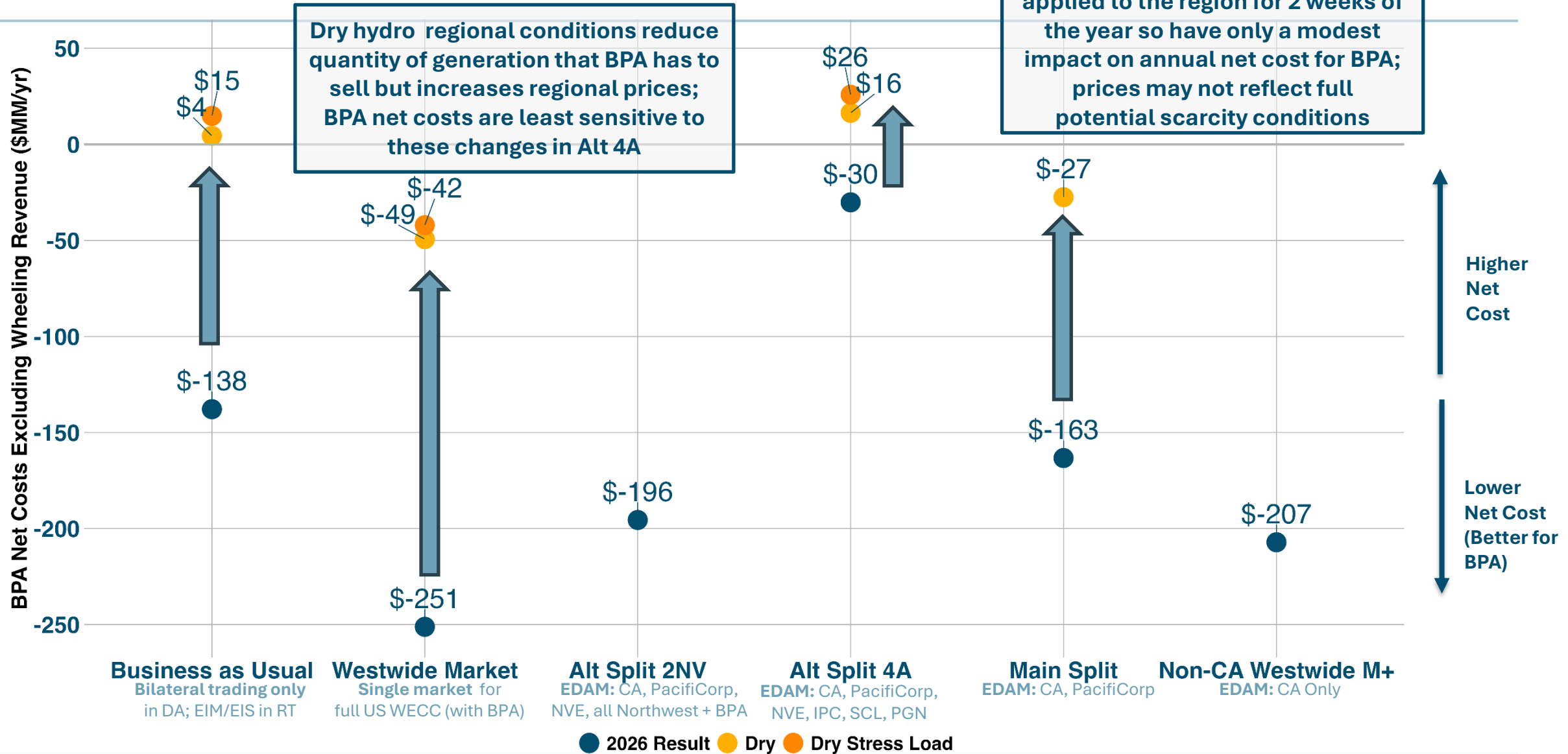
- + The historical load in the highest load week of summer and winter is **26%** and **28%** higher than the average seasonal load in NW zones
 - In the current model, the average peak week load is only 10% and 11% above the seasonal average load
 - Additional 14% and 15% are then applied to scale up the peak load in the highest RT load week of summer (July 24 - 30) and winter (Dec.4 - 10)
- + This reflects roughly a 1-in-5 “peak week” for load compared to seasonal average with 1-in-2 load
 - *No change applied to zones outside of NW region*

Example Summer Peak Week Stress Load Calculation Method

$(1+10\%) \times (1+14\%) = 126\%$ above seasonal avg load



2026 Cases & Dry Hydro and Stress Load

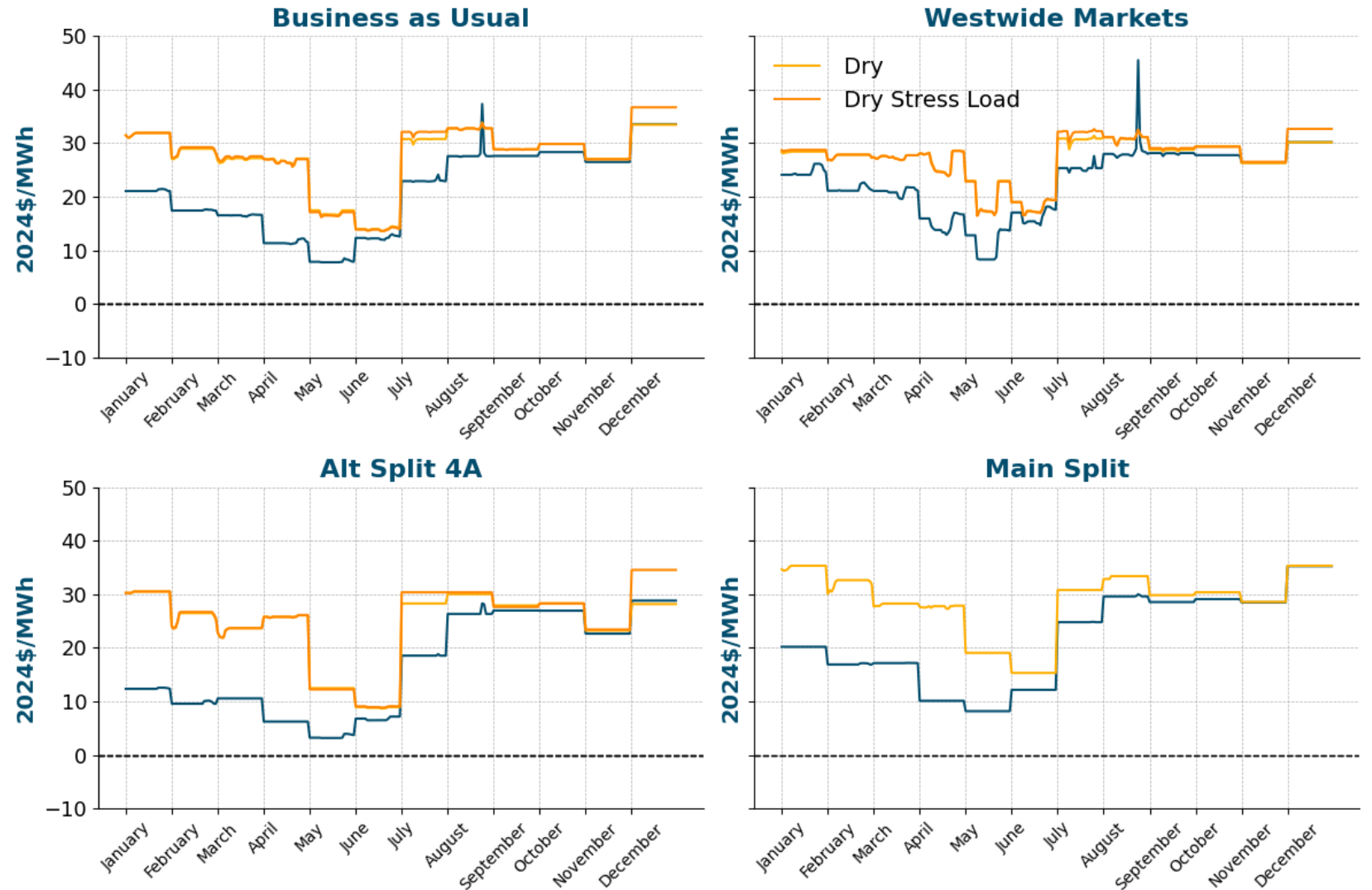


Primary drivers of results for Dry Hydro Conditions & Stress Load

Single Westwide Market case has the smallest change in market price during dry conditions because non-NW portion of footprint assumed unchanged

For all footprints, price changes are largest during spring when low hydro assumptions are most pronounced

Month-hour Average Price at BPA WA for typical, dry and stress load conditions



Moderate price increase when stress load applied for one December and one July week but not to fully year

+ The stress load condition tested the resiliency of the system

- Increased raised price by ~\$20/MWh in winter and ~\$10/MWh in summer
- Scarcity bidding was not added to this price impact; Actual market behavior could lead to more pronounced impact

+ BPA has less energy to sell in stress load conditions, which offsets the impact of higher prices on generation revenue



Improved Market to Market Coordination Assumptions

Key Question: How would improved Market to Market Coordination impact BPA market benefits?

+ **Market seams costs have significant impact on results for each footprint**

- Market seams increases market prices (and load cost) in the zones importing across seam, and reduces market prices (and generation revenue) in zones exporting across the same
- In markets such as Alt Split 4A where BPA is in a Northwest sub-area with fewer other participants, exports reduce local prices and generation revenue

+ **Market seams costs assumed for the WMEG model include transmission fees (assumed at the weighted average OATT rate of participants), plus transactional friction; additional cases for BPA tested sensitivity of results to the assumed cost of this friction**

+ **Baseline Assumptions:**

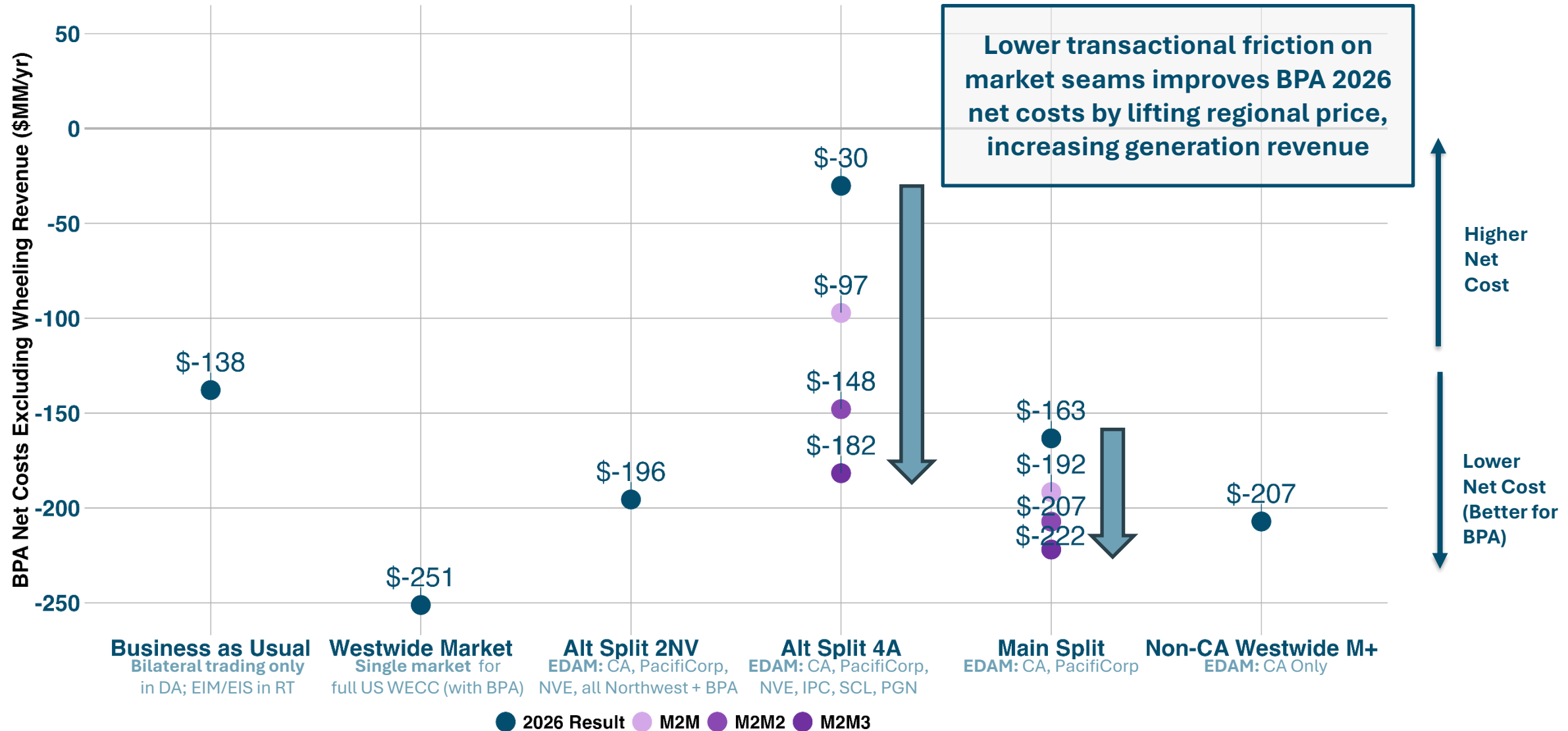
- BAU Case: OATT Rate for each BAA + \$2/MWh in transactional friction in DA; \$0 in RT between EIM or EIS entities
- M+ seams cost in DA & RT (applied when exiting M+ footprint): Weighted-average of OATT rates of Market participants (\$4.5/MWh for M+ in Alt Split 4A) + \$10 of transactional friction (for \$14.5/MWh total charge); \$0 charge for transactions between connected M+ participants

+ **In the M2M coordination cases, we apply various reductions to the friction on seams:**

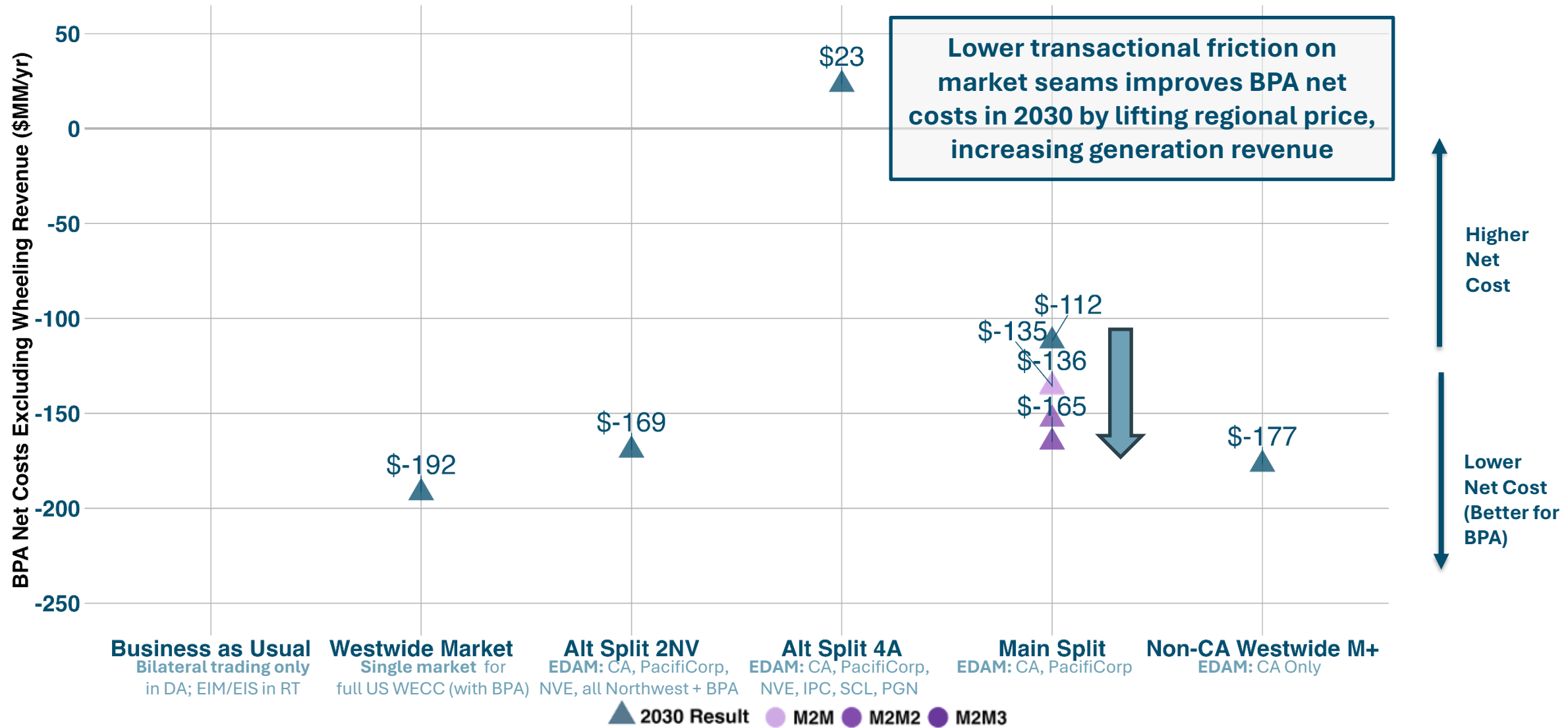
- M2M Case: \$10.5/MWh in DA; \$7.5/MWh in RT (Weighted average OATT + \$6/MWh in DA, \$3/MWh in RT)
- M2M2 Case: \$7.5/MWh in DA & RT (Weighted average OATT + \$3)
- M2M3 Case: \$5.25/MWh in DA & RT (50% of Weighted average OATT + \$3)

*Weighted average OATT is \$4.2/MWh for M+ footprint in main split due to slight differences in composition of members, reducing total hurdle rate by \$0.3/MWh across all sensitivities

2026 Cases & Increased Market to Market Coordination



2030 Cases & Increased Market to Market Coordination

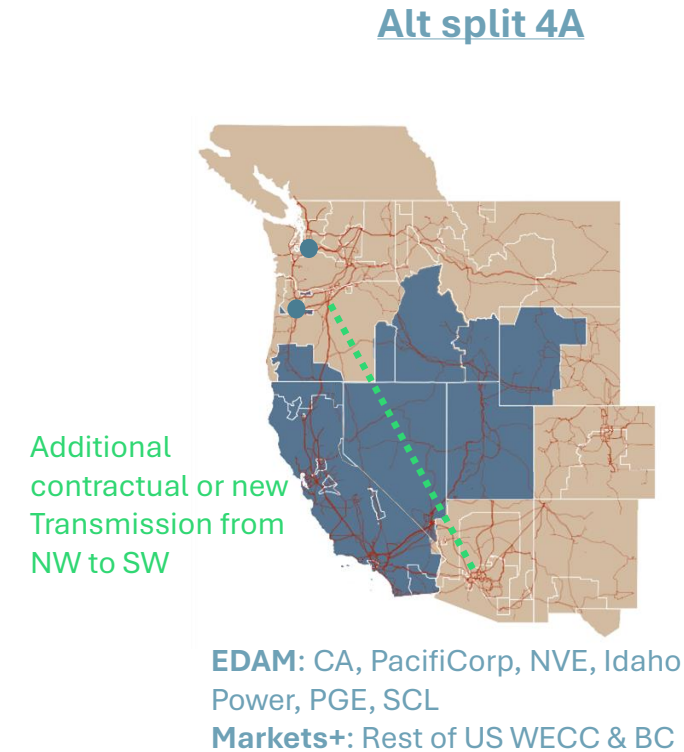


Improved Northwest to Southwest Transfer Capability

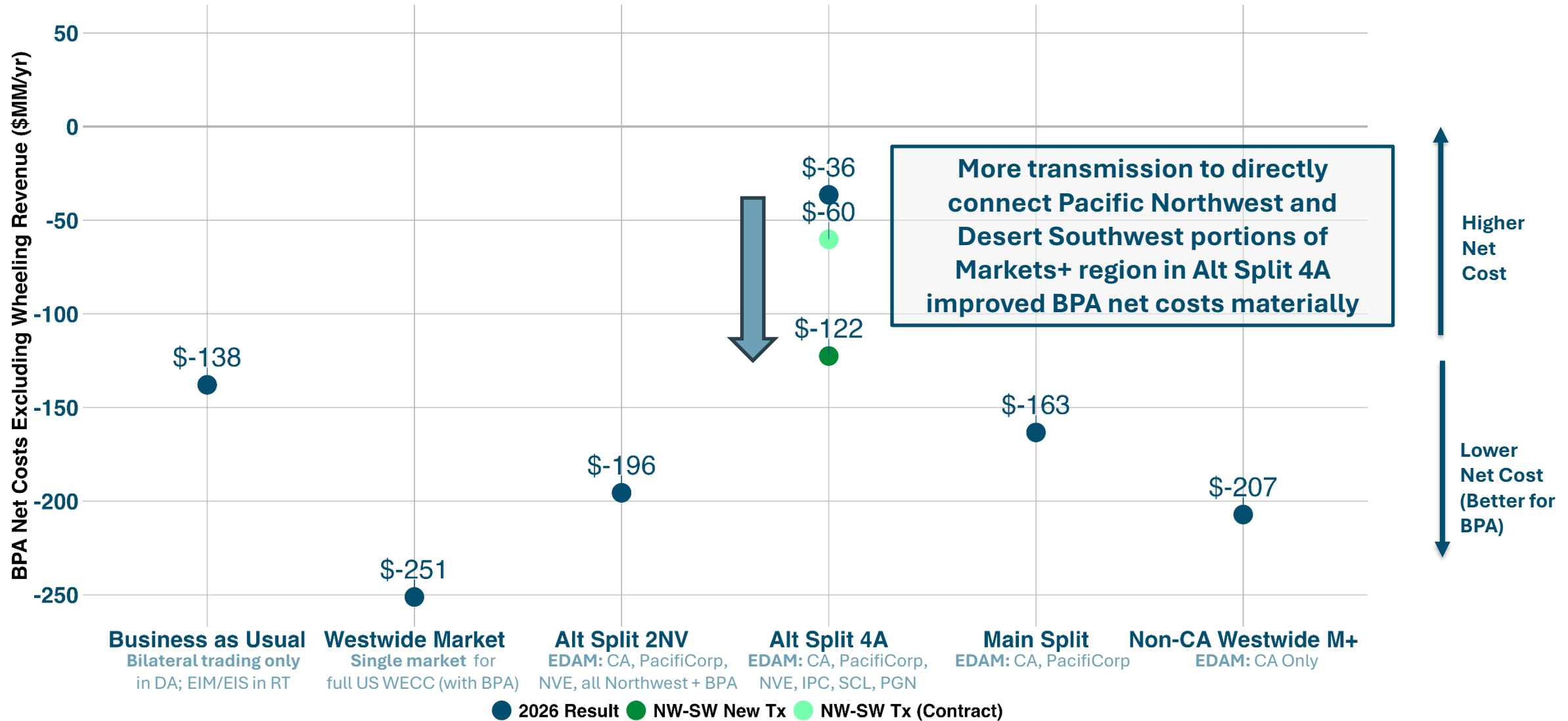
Assumptions

Key Question: How would improved NW to SW transmission capability impact BPA market benefits?

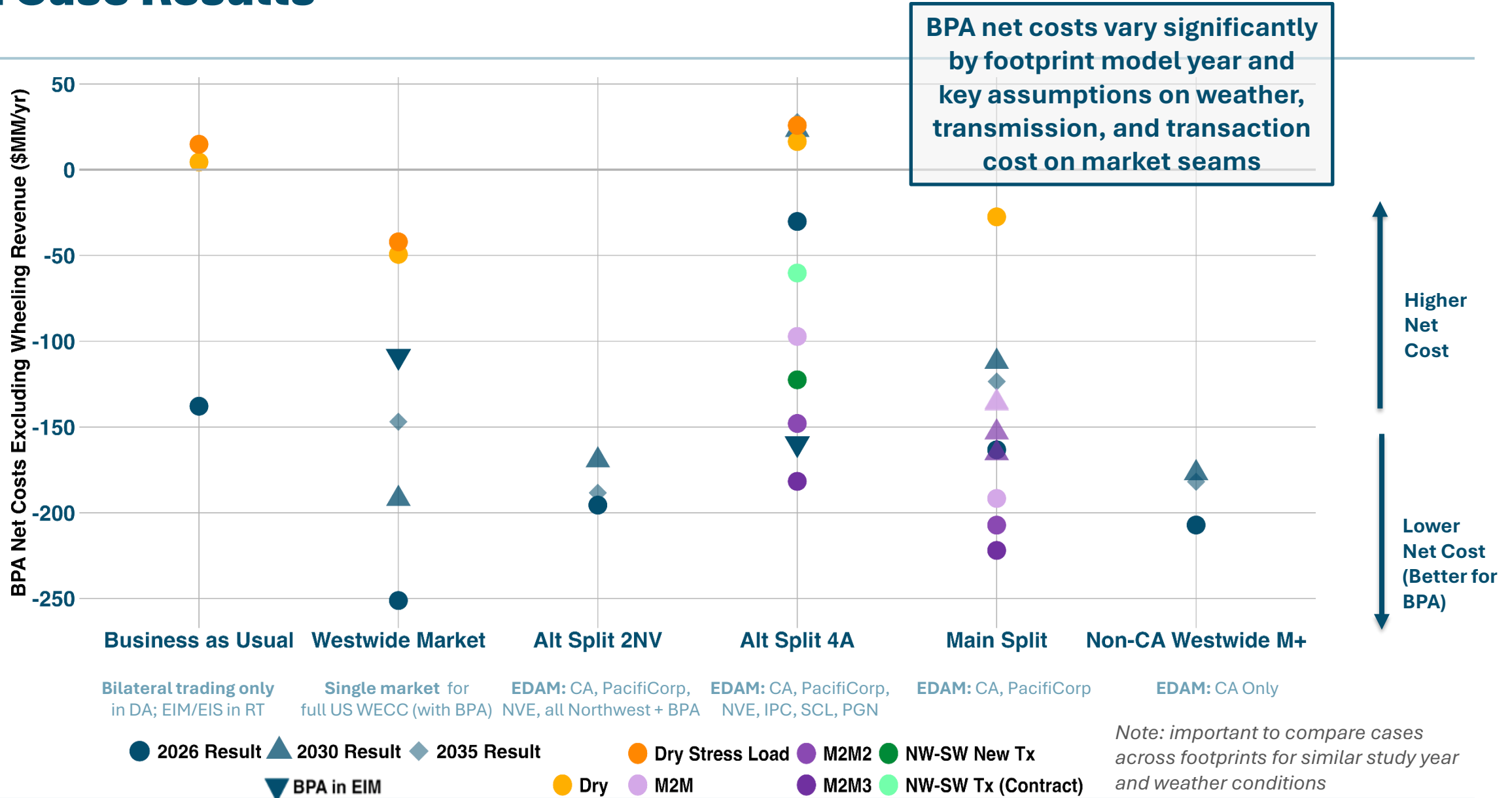
- + In Alt Split 4A Case, in-market transmission connectivity between Northwest and Southwest portions of M+ are limited to 400 MW of contract rights, resulting in significant price spreads between
- + E3 ran two scenarios to test impact on BPA of increasing this transfer capability:
 - **Additional NW-SW transmission contract scenario** modeled assigning 1000 MW of BPA-Palo Verde transmission capability assigned to M+ footprint (not new transmission, so reduced that on inter-market seams)
 - **New NW-SW transmission scenario** modeled 2000 MW of BPA-Palo Verde transmission (assumed as additional so did not reduce capability on seams)
- + **Note – these results do not represent a full accounting of the potential benefits of transmission**
 - Benefits shown here capture only energy cost and revenue impact, not cost of constructing or contracting for transmission; also, does not calculate the potential procurement or capacity benefits of the lines, which may be significant



2026 Cases with Improved Connectivity between NW and SW



All Case Results



Research on Additional Potential Impacts for BPA (Task 6)



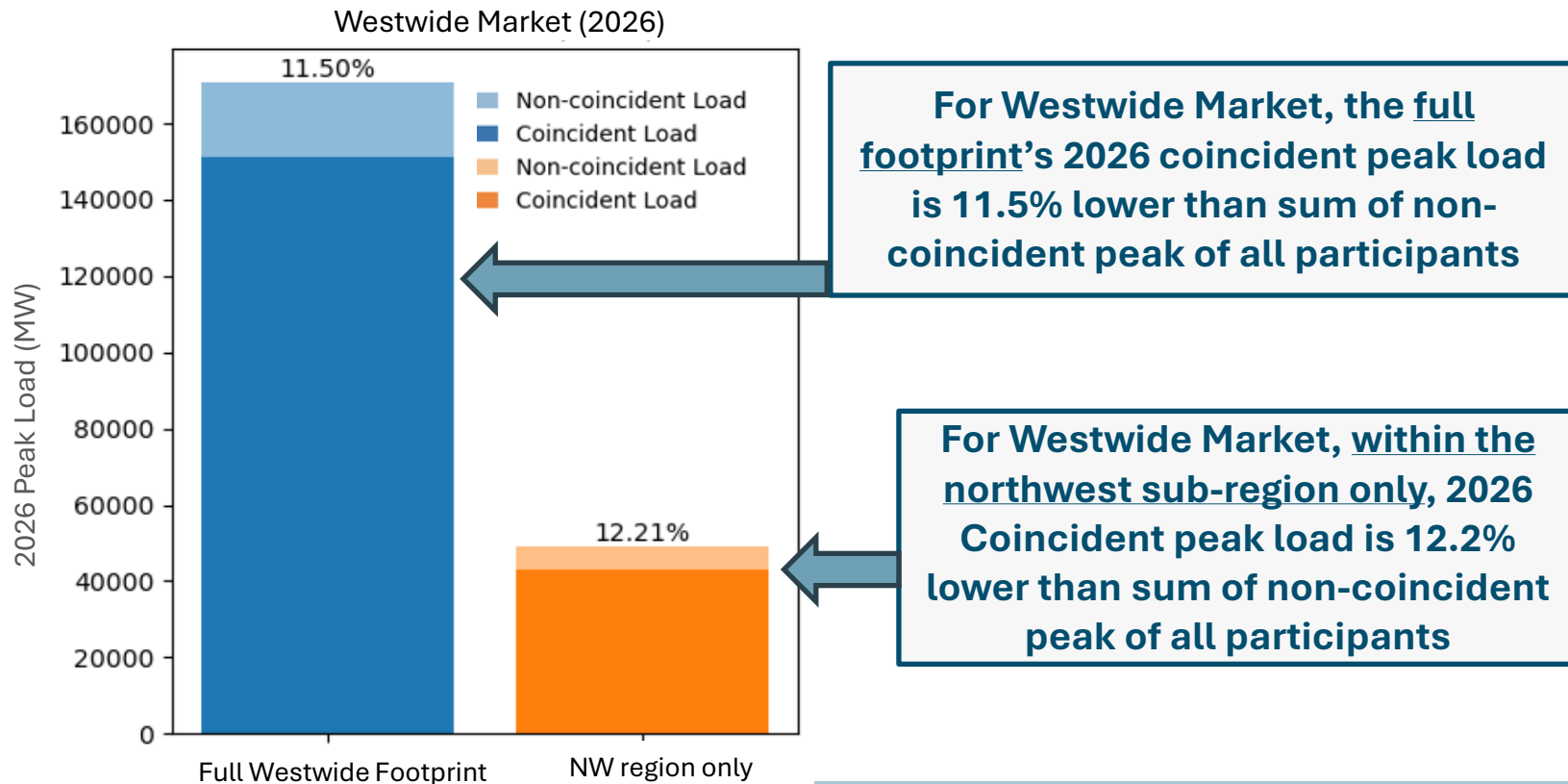
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Potential Capacity Value from Peak Load Diversity

Coincident vs. non-Coincident Peaks (Task 6)

Key Question: How would peak load diversity differ by market footprint & affect potential for capacity savings?

- + Larger geographical footprints have more peak load diversity (larger % change in coincident peak load vs. sum of non-coincident peaks of members), but results depend heavily on whether diversity assessed for full market footprint vs only Northwest sub-region
- + Economic potential is consequential: assuming a 12 GW peak load (BPA BAA) and \$100/kw-yr cost of capacity, each 1% reduction in need due to diversity could produce $12,000 \text{ MW} * 1\% = 120 \text{ MW savings} * \$100/\text{kw-yr} = \$12\text{MM}$ per year

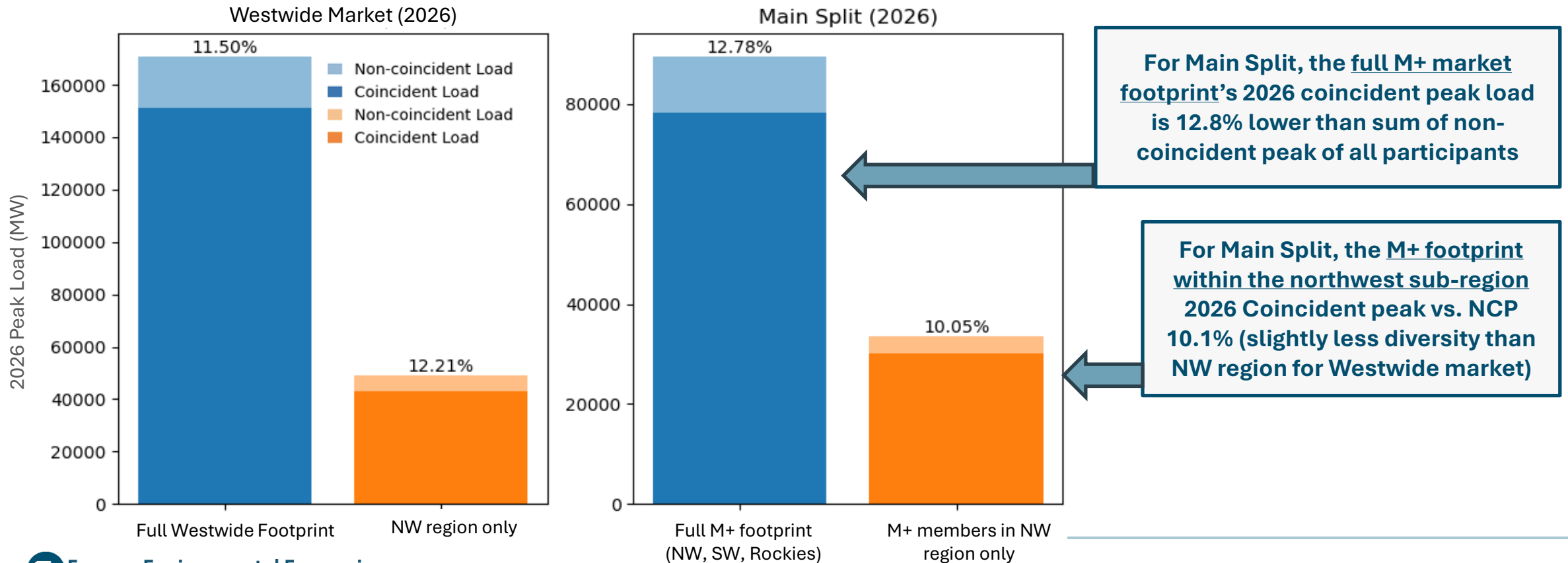


Potential Capacity Value from Peak Load Diversity

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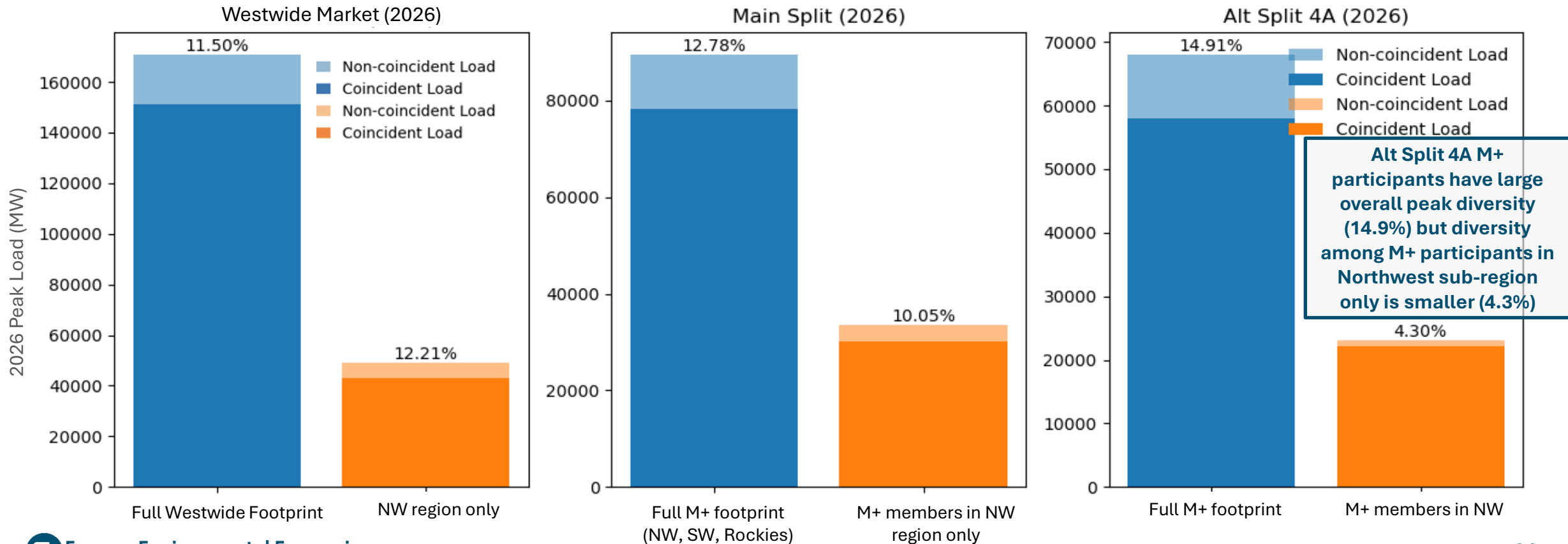


Potential Capacity Value from Peak Load Diversity

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Questions & Discussion



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Thank You

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Yuchi Sun, yuchi.sun@ethree.com



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Appendix: Additional Material



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BPA-Specific Results by Component – 2026 (\$ Millions)

BPA Task #	Case	Load Cost	Generation Cost	Generation Revenue	Wheeling Revenue	Congestion Revenue	GHG Revenue	Net Cost	Net Cost Excl Wheeling
WMEG	BAU (2026)	921	131	-1,140	-251	-50	0	-389	-138
WMEG	Main Split (2026)	924	131	-1,165	-27	-53	-1	-191	-163
Task 1	EDAM Bookend (2026)	944	131	-1,266	-5	-60	0	-257	-251
Task 2	Alt Split 4A M2M (2026)	818	131	-987	-150	-59	0	-248	-97
Task 2	Alt Split 4A M2M2 (2026)	874	131	-1,097	-123	-56	0	-271	-148
Task 2	Alt Split 4A M2M3 (2026)	910	131	-1,166	-93	-57	0	-275	-182
Task 2	Main Split M2M (2026)	961	131	-1,231	-38	-52	-1	-230	-192
Task 2	Main Split M2M2 (2026)	981	131	-1,265	-33	-54	-1	-241	-207
Task 2	Main Split M2M3 (2026)	983	131	-1,279	-28	-57	-1	-250	-222
Task 3	BAU Dry (2026)	1,104	131	-1,201	-185	-30	0	-180	4
Task 3	BAU Dry Stress Load (2026)	1,132	131	-1,218	-184	-30	0	-169	15
Task 3	EDAM Bookend Dry (2026)	1,043	131	-1,184	-5	-39	0	-55	-49
Task 3	EDAM Bookend Dry Stress Load (2026)	1,067	131	-1,201	-6	-38	0	-48	-42
Task 3	Alt Split 4A Dry (2026)	957	131	-1,032	-98	-39	0	-82	16
Task 3	Alt Split 4A Dry Stress Load (2026)	1,001	131	-1,067	-99	-39	0	-73	26
Task 3	Main Split Dry (2026)	1,152	131	-1,284	-23	-26	-1	-50	-27
Task 4	EDAM Bookend BPA EIM-Only (2026)	840	131	-1,028	-216	-52	0	-324	-109
Task 4	EDAM Bookend BPA EIM-Only Dry Stress Load (2026)	1,018	131	-1,104	-148	-31	0	-134	14
Task 4	Alt Split 4A BPA EIM-Only Dry Stress Load (2026)	1,109	131	-1,203	-166	-31	0	-161	5
Task 4	Alt Split 4A BPA EIM-Only (2026)	908	131	-1,129	-238	-69	0	-398	-160
Task 5	Alt Split 4A NW-SW New Tx (2026)	811	131	-977	-134	-88	0	-256	-122
Task 5	Alt Split 4A NW-SW TX (Contract) (2026)	811	131	-977	-134	-88	0	-429	-122
Task 9	Alt Split 4A (2026)	739	131	-835	-173	-65	0	-203	-30
Task 10	Non-CA Westwide M+ (2026)	890	131	-1,182	-23	-46	0	-231	-207
Task 11	Alt Split 2NV (2026)	873	131	-1,155	-10	-44	0	-206	-196

BPA-Specific Results by Component – 2030 + 2035 (\$ Millions)

2030 Results

BPA Task #	Case	Load Cost	Generation Cost	Generation Revenue	Wheeling Revenue	Congestion Revenue	GhG Revenue	Net Cost	Net Cost Excl Wheeling
WMEG	Main Split (2030)	951	131	-1,109	-41	-85	0	-153	-112
Task 1	EDAM Bookend (2030)	974	131	-1,207	-9	-91	0	-201	-192
Task 2	Main Split M2M (2030)	983	131	-1,165	-41	-84	0	-176	-135
Task 2	Main Split M2M2 (2030)	1,001	131	-1,199	-35	-85	0	-188	-153
Task 2	Main Split M2M3 (2030)	1,003	131	-1,211	-28	-88	0	-193	-165
Task 9	Alt Split 4A (2030)	770	131	-794	-176	-84	0	-153	23
Task 10	Non-CA Westwide M+ (2030)	943	131	-1,183	-28	-68	0	-205	-177
Task 11	Alt Split 2NV (2030)	924	131	-1,154	-10	-70	0	-179	-169

2035 Results

BPA Task #	Case	Load Cost	Generation Cost	Generation Revenue	Wheeling Revenue	Congestion Revenue	GhG Revenue	Net Cost	Net Cost Excl Wheeling
WMEG	Main Split (2035)	1,088	131	-1,244	-38	-99	0	-162	-123
Task 1	EDAM Bookend (2035)	1,017	131	-1,150	-11	-145	0	-158	-147
Task 9	Alt Split 4A (2035)	894	131	-899	-201	-98	0	-173	28
Task 10	Non-CA Westwide M+ (2035)	1,062	131	-1,296	-26	-79	0	-208	-182
Task 11	Alt Split 2NV (2035)	1,034	131	-1,251	-17	-102	0	-205	-188